§ 98.341 Reporting threshold.

You must report GHG emissions under this subpart if your facility contains a MSW landfill and the facility meets the requirements of § 98.2(a)(1).

§ 98.342 GHGs to report.

(a) You must report CH_4 generation and CH_4 emissions from landfills.

(b) You must report CH_4 destruction resulting from landfill gas collection and combustion systems.

(c) You must report under subpart C of this part (General Stationary Fuel Combustion Sources) the emissions of CO_2, CH_4, and N_2O from each stationary combustion unit following the requirements of subpart C.

§ 98.343 Calculating GHG emissions.

(a) For all landfills subject to the reporting requirements of this subpart, calculate annual modeled CH_4 generation according to the applicable requirements in paragraphs (a)(1) through (a)(3) of this section.

(1) Calculate annual modeled CH_4 generation using Equation HH–1 of this section.

$$G_{CH4} = \sum_{x=S}^{T-1} \left\{ W_x \times MCF \times DOC \times DOC_F \times F \times \frac{16}{12} \times \left(e^{-k(T-x-1)} - e^{-k(T-x)} \right) \right\} \qquad \text{(Eq. HH-1)}$$

Where:

G_{CH4} = Modeled methane generation rate in reporting year T (metric tons CH_4).

x = Year in which waste was disposed.

S = Start year of calculation. Use the year 1960 or the opening year of the landfill, whichever is more recent.

T = Reporting year for which emissions are calculated.

W_X = Quantity of waste disposed in the landfill in year x from measurement data, tipping fee receipts, or other company records (metric tons, as received (wet weight)).

MCF = Methane correction factor (fraction). Use the default value of 1 unless there is active aeration of waste within the landfill during the reporting year. If there is active aeration of waste within the landfill during the reporting year, use either the default value of 1 or select an alternative value no less than 0.5 based on site-specific aeration parameters.

DOC = Degradable organic carbon from Table HH–1 of this subpart [fraction (metric tons C/metric ton waste)].

DOC_F = Fraction of DOC dissimilated (fraction). Use the default value of 0.5.

F = Fraction by volume of CH_4 in landfill gas from measurement data for the current reporting year, if available (fraction, dry basis, corrected to 0% oxygen); otherwise, use the default of 0.5.

k = Rate constant from Table HH–1 to this subpart (yr^{-1}). Select the most applicable k value for the majority of the past 10 years (or operating life, whichever is shorter).

(2) For years when material-specific waste quantity data are available, apply Equation HH–1 of this section for each waste quantity type and sum the CH_4 generation rates for all waste types to calculate the total modeled CH_4 generation rate for the landfill. Use the appropriate parameter values for k, DOC, MCF, DOC_F, and F shown in Table HH–1 of this subpart. The annual quantity of each type of waste disposed must be calculated as the sum of the daily quantities of waste (of that type) disposed. You may use the bulk waste parameters for a portion of your waste materials when using the material-specific modeling approach for mixed waste streams that cannot be designated to a specific material type. For years when waste composition data are not available, use the bulk waste parameter values for k and DOC in Table HH–1 to this subpart for the total quantity of waste disposed in those years.

(3) Beginning in the first emissions reporting year and for each year thereafter, if scales are in place, you must determine the annual quantity of waste (in metric tons as received, i.e., wet weight) disposed of in the landfill using paragraph (a)(3)(i) of this section for all containers and for all vehicles used to haul waste to the landfill, except for passenger cars, light duty pickup trucks, or waste loads that cannot be measured using the scales due to physical limitations (load cannot physically access or fit on the scale) and/or

operational limitations of the scale (load exceeding the limits or sensitivity range of the scale). If scales are not in place, you must use paragraph (a)(3)(ii) of this section to determine the annual quantity of waste disposed. For waste hauled to the landfill in passenger cars or light duty pickup trucks, you may use either paragraph (a)(3)(i) or paragraph (a)(3)(ii) of this section to determine the annual quantity of waste disposed. For loads that cannot be measured using the scales due to physical and/or operational limitations of the scale, you must use paragraph (a)(3)(ii) of this section or similar engineering calculations to determine the annual quantity of waste disposed. The approach used to determine the annual quantity of waste disposed of must be documented in the monitoring plan.

(i) Use direct mass measurements of each individual load received at the landfill using either of the following methods:

(A) Weigh using mass scales each vehicle or container used to haul waste as it enters the landfill or disposal area; weigh using mass scales each vehicle or container after it has off-loaded the waste; determine the quantity of waste received from the individual load as the difference in the two mass measurements; and determine the annual quantity of waste received as the sum of all waste loads received during the year. Alternatively, you may determine annual quantity of waste by summing the weights of all vehicles and containers entering the landfill and subtracting from it the sum of all the weights of vehicles and containers after they have off-loaded the waste in the landfill.

(B) Weigh using mass scales each vehicle or container used to haul waste as it enters the landfill or disposal area; determine a representative tare weight by vehicle or container type by weighing no less than 5 of each type of vehicle or container after it has off-loaded the waste; determine the quantity of waste received from the individual load as the difference between the measured weight in and the tare weight determined for that container/vehicle type; and determine the annual quantity of waste received as the sum of all waste loads received during the year.

(ii) Determine the working capacity in units of mass for each type of container or vehicle used to haul waste to the landfill (*e.g.*, using volumetric capacity and waste density measurements; direct measurement of a selected number of passenger vehicles and light duty pick-up trucks; or similar methods); record the number of loads received at the landfill by vehicle/container type; calculate the annual mass per vehicle/container type as the mass product of the number of loads of that vehicle/container multiplied by its working capacity; and calculate the annual quantity of waste received as the sum of the annual mass per vehicle/container type across all of the vehicle/container types used to haul waste to the landfill.

(4) For years prior to the first emissions reporting year, use methods in paragraph (a)(3) of this section when waste disposal quantity data are readily available. When waste disposal quantity data are not readily available, W_X shall be estimated using one of the applicable methods in paragraphs (a)(4)(i) through (a)(4)(iii) of this section. You must determine which method is most applicable to the conditions and disposal history of your facility. Historical waste disposal quantities should only be determined once, as part of the first annual report, and the same values should be used for all subsequent annual reports, supplemented by the next year's data on new waste disposal.

(i) Assume all prior years waste disposal quantities are the same as the waste quantity in the first year for which waste quantities are available.

(ii) Use the estimated population served by the landfill in each year, the values for national average per capita waste disposal rates found in Table HH–2 to this subpart, and calculate the waste quantity landfilled using Equation HH–2 of this section.

$$W_x = POP_x \times WDR_x \qquad \text{(Eq. HH-2)}$$

where:

W_X = Quantity of waste placed in the landfill in year x (metric tons, wet basis).

POP_X = Population served by the landfill in year x from city population, census data, or other estimates (capita).

WDR_X = Average per capita waste disposal rate for year x from Table HH–2 to this subpart (metric tons per capita per year, wet basis; tons/cap/yr).

(iii) Use a constant average waste disposal quantity calculated using Equation HH–3 of this section for each year the landfill was in operation (i.e., from the first year accepting waste until the last year for which waste disposal data is unavailable, inclusive).

$$W_x = \frac{LFC}{(YrData - YrOpen + 1)} \quad \text{(Eq. HH-3)}$$

where:

W_X = Quantity of waste placed in the landfill in year x (metric tons, wet basis).

LFC = Landfill capacity or, for operating landfills, capacity of the landfill used (or the total quantity of waste-in-place) at the end of the year prior to the year when waste disposal data are available from design drawings or engineering estimates (metric tons).

YrData = Year in which the landfill last received waste or, for operating landfills, the year prior to the first reporting year when waste disposal data is first available from company records, or best available data.

YrOpen = Year in which the landfill first received waste from company records or best available data. If no data are available for estimating YrOpen for a closed landfill, use 30 years as the default operating life of the landfill.

(b) For landfills with gas collection systems, calculate the quantity of CH_4 destroyed according to the requirements in paragraphs (b)(1) and (b)(2) of this section.

(1) If you continuously monitor the flow rate, CH_4 concentration, temperature, pressure, and, if necessary, moisture content of the landfill gas that is collected and routed to a destruction device (before any treatment equipment) using a monitoring meter specifically for CH_4 gas, as specified in § 98.344, you must use this monitoring system and calculate the quantity of CH_4 recovered for destruction using Equation HH–4 of this section. A fully integrated system that directly reports CH_4 content requires no other calculation than summing the results of all monitoring periods for a given year.

$$R = \sum_{n=1}^{N} \left((V)_n \times (K_{MC})_n \times \frac{(C_{CH4})_n}{100\%} \times 0.0423 \times \frac{520°R}{(T)_n} \times \frac{(P)_n}{1\,atm} \times \frac{0.454}{1,000} \right) \quad \text{(Eq. HH-4)}$$

where:

R = Annual quantity of recovered CH_4 (metric tons CH_4).

N = Total number of measurement periods in a year. Use daily averaging periods for a continuous monitoring system and N = 365 (or N = 366 for leap years). For monthly sampling, as provided in paragraph (b)(2) of this section, use N=12.

n = Index for measurement period.

$(V)_n$ = Cumulative volumetric flow for the measurement period in actual cubic feet (acf). If the flow rate meter automatically corrects for temperature and pressure, replace "$520°R/(T)_n \times (P)_n/1\,atm$" with "1".

$(K_{MC})_n$ = Moisture correction term for the measurement period, volumetric basis, as follows: $(K_{MC})_n = 1$ when $(V)_n$ and $(C)_n$ are both measured on a dry basis or if both are measured on a wet basis; $(K_{MC})_n = [1-(f_{H2O})_n]$ when $(V)_n$ is measured on a wet basis and $(C)_n$ is measured on a dry basis; and $(K_{MC})_n = 1/[1-(f_{H2O})_n]$ when $(V)_n$ is measured on a dry basis and $(C)_n$ is measured on a wet basis.

$(f_{H2O})_n$ = Average moisture content of landfill gas during the measurement period, volumetric basis (cubic feet water per cubic feet landfill gas)

$(C_{CH4})_n$ = Average CH_4 concentration of landfill gas for the measurement period (volume %).

0.0423 = Density of CH_4 lb/cf at 520°R or 60 degrees Fahrenheit and 1 atm.

$(T)_n$ = Average temperature at which flow is measured for the measurement period (°R).

$(P)_n$ = Average pressure at which flow is measured for the measurement period (atm).

0.454/1,000 = Conversion factor (metric ton/lb).

(2) If you do not continuously monitor according to paragraph (b)(1) of this section, you must determine the flow rate, CH_4 concentration, temperature, pressure, and moisture content of

the landfill gas that is collected and routed to a destruction device (before any treatment equipment) according to the requirements in paragraphs (b)(2)(i) through (b)(2)(iii) of this section and calculate the quantity of CH_4 recovered for destruction using Equation HH–4 of this section.

(i) Continuously monitor gas flow rate and determine the cumulative volume of landfill gas each month and the cumulative volume of landfill gas each year that is collected and routed to a destruction device (before any treatment equipment). Under this option, the gas flow meter is not required to automatically correct for temperature, pressure, or, if necessary, moisture content. If the gas flow meter is not equipped with automatic correction for temperature, pressure, or, if necessary, moisture content, you must determine these parameters as specified in paragraph (b)(2)(iii) of this section.

(ii) Determine the CH_4 concentration in the landfill gas that is collected and routed to a destruction device (before any treatment equipment) in a location near or representative of the location of the gas flow meter at least once each calendar month; if only one measurement is made each calendar month, there must be at least fourteen days between measurements.

(iii) If the gas flow meter is not equipped with automatic correction for temperature, pressure, or, if necessary, moisture content:

(A) Determine the temperature and pressure in the landfill gas that is collected and routed to a destruction device (before any treatment equipment) in a location near or representative of the location of the gas flow meter at least once each calendar month; if only one measurement is made each calendar month, there must be at least fourteen days between measurements.

(B) If the CH_4 concentration is determined on a dry basis and flow is determined on a wet basis or CH_4 concentration is determined on a wet basis and

flow is determined on a dry basis, and the flow meter does not automatically correct for moisture content, determine the moisture content in the landfill gas that is collected and routed to a destruction device (before any treatment equipment) in a location near or representative of the location of the gas flow meter at least once each calendar month; if only one measurement is made each calendar month, there must be at least fourteen days between measurements.

(c) For all landfills, calculate CH_4 generation (adjusted for oxidation in cover materials) and actual CH_4 emissions (taking into account any CH_4 recovery, and oxidation in cover materials) according to the applicable methods in paragraphs (c)(1) through (c)(3) of this section.

(1) Calculate CH_4 generation, adjusted for oxidation, from the modeled CH_4 (G_{CH_4} from Equation HH–1 of this section) using Equation HH–5 of this section.

$$MG = G_{CH4} \times (1 - OX) \qquad \text{(Eq. HH-5)}$$

Where:

MG = Methane generation, adjusted for oxidation, from the landfill in the reporting year (metric tons CH_4).
G_{CH_4} = Modeled methane generation rate in reporting year from Equation HH–1 of this section (metric tons CH_4).
OX = Oxidation fraction. Use the appropriate oxidation fraction default value from Table HH–4 of this subpart.

(2) For landfills that do not have landfill gas collection systems, the CH_4 emissions are equal to the CH_4 generation (MG) calculated in Equation HH–5 of this section.

(3) For landfills with landfill gas collection systems, calculate CH_4 emissions using the methodologies specified in paragraphs (c)(3)(i) and (c)(3)(ii) of this section.

(i) Calculate CH_4 emissions from the modeled CH_4 generation and measured CH_4 recovery using Equation HH–6 of this section.

$$\text{Emissions} = \left[\left(G_{CH4} - \sum_{n-1}^{N} R_n \right) \times (1 - OX) + \sum_{n-1}^{N} \left\{ R_n \times \left(1 - \left(DE_n \times f_{Dest,n} \right) \right) \right\} \right] \qquad \text{(Eq. HH-6)}$$

Where:

Emissions = Methane emissions from the landfill in the reporting year (metric tons CH_4).

G_{CH4} = Modeled methane generation rate in reporting year from Equation HH–1 of this section or the quantity of recovered CH_4 from Equation HH–4 of this section, whichever is greater (metric tons CH_4).

N = Number of landfill gas measurement locations (associated with a destruction device or gas sent off-site). If a single monitoring location is used to monitor volumetric flow and CH_4 concentration of the recovered gas sent to one or multiple destruction devices, then N=1.

R_n = Quantity of recovered CH_4 from Equation HH–4 of this section for the nth measurement location (metric tons).

OX = Oxidation fraction. Use the appropriate oxidation fraction default value from Table HH–4 of this subpart.

DE_n = Destruction efficiency (lesser of manufacturer's specified destruction efficiency and 0.99) for the nth measurement location. If the gas is transported off-site for destruction, use DE = 1. If the volumetric flow and CH_4 concentration of the recovered gas is measured at a single location providing landfill gas to multiple destruction devices (including some gas de-stroyed on-site and some gas sent off-site for destruction), calculate DE_n as the arithmetic average of the DE values determined for each destruction device associated with that measurement location.

$f_{Dest,n}$ = Fraction of hours the destruction device associated with the nth measurement location was operating during active gas flow calculated as the annual operating hours for the destruction device divided by the annual hours flow was sent to the destruction device as measured at the nth measurement location. If the gas is transported off-site for destruction, use $f_{Dest,n}$= 1. If the volumetric flow and CH_4 concentration of the recovered gas is measured at a single location providing landfill gas to multiple destruction devices (including some gas destroyed on-site and some gas sent off-site for destruction), calculate $f_{Dest,n}$ as the arithmetic average of the f_{Dest} values determined for each destruction device associated with that measurement location.

(ii) Calculate CH_4 generation and CH_4 emissions using measured CH_4 recovery and estimated gas collection efficiency and Equations HH–7 and HH–8 of this section.

$$MG = \frac{1}{CE} \sum_{n=1}^{N} \left[\frac{R_n}{f_{Rec,n}} \right] \times (1 - OX) \qquad \text{(Eq. HH-7)}$$

$$Emissions = \left[\left(\frac{1}{CE} \left\{ \sum_{n=1}^{N} \left[\frac{R_n}{f_{Rec,n}} \right] \right\} - \sum_{n=1}^{N} R_n \right) \times (1 - OX) + \sum_{n=1}^{N} \left\{ R_n \times \left(1 - \left(DE_n \times f_{Dest,n} \right) \right) \right\} \right] \qquad \text{(Eq. HH-8)}$$

Where:

MG = Methane generation, adjusted for oxidation, from the landfill in the reporting year (metric tons CH_4).

Emissions = Methane emissions from the landfill in the reporting year (metric tons CH_4).

N = Number of landfill gas measurement locations (associated with a destruction device or gas sent off-site). If a single monitoring location is used to monitor volumetric flow and CH_4 concentration of the recovered gas sent to one or multiple destruction devices, then N=1.

R_n = Quantity of recovered CH_4 from Equation HH–4 of this section for the nth measurement location (metric tons CH_4).

CE = Collection efficiency estimated at landfill, taking into account system cov-erage, operation, and cover system materials from Table HH–3 of this subpart. If area by soil cover type information is not available, use default value of 0.75 (CE4 in table HH–3 of this subpart) for all areas under active influence of the collection system.

$f_{Rec,n}$ = Fraction of hours the recovery system associated with the nth measurement location was operating (annual operating hours/8760 hours per year or annual operating hours/8784 hours per year for a leap year).

OX = Oxidation fraction. Use appropriate oxidation fraction default value from Table HH–4 of this subpart.

DE_n = Destruction efficiency, (lesser of manufacturer's specified destruction efficiency and 0.99) for the nth measurement

location. If the gas is transported off-site for destruction, use DE = 1. If the volumetric flow and CH_4 concentration of the recovered gas is measured at a single location providing landfill gas to multiple destruction devices (including some gas destroyed on-site and some gas sent off-site for destruction), calculate DE_n as the arithmetic average of the DE values determined for each destruction device associated with that measurement location.

$f_{Dest,n}$ = Fraction of hours the destruction device associated with the nth measurement location was operating during active gas flow calculated as the annual operating hours for the destruction device divided by the annual hours flow was sent to the destruction device as measured at the nth measurement location. If the gas is transported off-site for destruction, use $f_{Dest,n}$= 1. If the volumetric flow and CH_4 concentration of the recovered gas is measured at a single location providing landfill gas to multiple destruction devices (including some gas destroyed on-site and some gas sent off-site for destruction), calculate $f_{Dest,n}$ as the arithmetic average of the f_{Dest} values determined for each destruction device associated with that measurement location.

[74 FR 56374, Oct. 30, 2009, as amended at 75 FR 66470, Oct. 28, 2010; 78 FR 71968, Nov. 29, 2013]

§ 98.344 Monitoring and QA/QC requirements.

(a) Mass measurement equipment used to determine the quantity of waste landfilled on or after January 1, 2010 must meet the requirements for weighing equipment as described in ''Specifications, Tolerances, and Other Technical Requirements For Weighing and Measuring Devices'' NIST Handbook 44 (2009) (incorporated by reference, see § 98.7).

(b) For landfills with gas collection systems, operate, maintain, and calibrate a gas composition monitor capable of measuring the concentration of CH_4 in the recovered landfill gas using one of the methods specified in paragraphs (b)(1) through (b)(6) of this section or as specified by the manufacturer. Gas composition monitors shall be calibrated prior to the first reporting year and recalibrated either annually or at the minimum frequency specified by the manufacturer, whichever is more frequent, or whenever the error in the midrange calibration check exceeds ±10 percent.

(1) Method 18 at 40 CFR part 60, appendix A–6.

(2) ASTM D1945–03, Standard Test Method for Analysis of Natural Gas by Gas Chromatography (incorporated by reference, see § 98.7).

(3) ASTM D1946–90 (Reapproved 2006), Standard Practice for Analysis of Reformed Gas by Gas Chromatography (incorporated by reference, see § 98.7).

(4) GPA Standard 2261–00, Analysis for Natural Gas and Similar Gaseous Mixtures by Gas Chromatography.

(5) UOP539–97 Refinery Gas Analysis by Gas Chromatography (incorporated by reference, see § 98.7).

(6) As an alternative to the gas chromatography methods provided in paragraphs (b)(1) through (b)(5) of this section, you may use total gaseous organic concentration analyzers and calculate the methane concentration following the requirements in paragraphs (b)(6)(i) through (b)(6)(iii) of this section.

(i) Use Method 25A or 25B at 40 CFR part 60, appendix A–7 to determine total gaseous organic concentration. You must calibrate the instrument with methane and determine the total gaseous organic concentration as carbon (or as methane; K=1 in Equation 25A–1 of Method 25A at 40 CFR part 60, appendix A–7).

(ii) Determine a non-methane organic carbon correction factor at the routine sampling location no less frequently than once a reporting year following the requirements in paragraphs (b)(6)(ii)(A) through (b)(6)(ii)(C) of this section.

(A) Take a minimum of three grab samples of the landfill gas with a minimum of 20 minutes between samples and determine the methane composition of the landfill gas using one of the methods specified in paragraphs (b)(1) through (b)(5) of this section.

(B) As soon as practical after each grab sample is collected and prior to the collection of a subsequent grab sample, determine the total gaseous organic concentration of the landfill gas using either Method 25A or 25B at 40 CFR part 60, appendix A–7 as specified in paragraph (b)(6)(i) of this section.

(C) Determine the arithmetic average methane concentration and the arithmetic average total gaseous organic